PATENT SPECIFICATION

959,383

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COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Improvements in or relating to Nuclear Reactors

WE, ESCHER WYSS AKTIENGESELLSCHAFT, a Swiss Body Corporate, of Hardstrasse 319, Zurich, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement :—

This invention relates to devices for regulating nuclear reactors.

Among the devices used to regulate nuclear reactors are those in which, for varying the reactivity of the reactor, neutron-absorbing rod-like control elements are inserted into the reactor. In these devices the rods are inserted from one side of the reactor, the length of the rods being such that, when fully inserted, they pass practically entirely through the reactor core.

This arrangement has however the disadvantage that, with partial insertion of the control rods, the neutron flux of the reactor is influenced only on one side. There is thus a very uneven distribution of heat generation in the reactor. In addition, a comparatively large amount of free space is needed outside the reactor core in order to be able to withdraw the rods.

Accordingly, the present invention relates to a device for regulating a nuclear reactor which comprises at least one pair of neutron-absorbing control elements arranged for insertion into the reactor so as to vary its reactivity, in which the elements of a pair are arranged on opposite sides of the reactor and are so coupled together that, on operation of the regulating device, they move simultaneously by substantially the same distance in opposite directions to each other.

Constructional examples of the invention are illustrated in simplified form in the accompanying drawings, wherein :—

Figure 1 shows an axial longitudinal section through one constructional form of the device ;

Figure 2 shows a part of another constructional form ;

Figure 3 shows a section on the line III-III of Figure 2 ;

Figure 4 shows how the elements of Figure 2 can be guided over a chain wheel ;

Figure 5 shows a part of Figure 4 on a larger scale ; and

Figure 6 shows a section taken on the line VI-VI in Figure 5.

In Figure 1 the wall 1 of the pressure vessel encloses the reactor consisting of a core 2 containing the reactor fuel and a reflector 3. For receiving the control devices, channels 5 passing through the reactor and confined by tubes 4 are provided, of which, for the sake of simplicity, only one is shown in the Figure. The tube 4 adjoins an opening 6 of the pressure vessel 1.

The regulating device has a pair of rod-like control elements 7 consisting of neutron-absorbing substance. These elements 7 are movably arranged within the tube 4 on opposite sides of the reactor in the axial direction in such a manner that they can be inserted by a greater or smaller distance into the reactor for varying its reactivity

The two rod-like control elements 7 are connected together by a cable 8 which on one side is passed over guide rollers 9, a tensioning roller 11 loaded by a spring 10, and a driving roller 12 actuated by means not shown, and on the other side over guide rollers 13 and a deflecting roller 14

The rollers 9 and 11, as well as the driving roller 12, are accommodated in a housing 15 flanged on to the outside of the pressure vessel 1, while the rollers 13, 14 are situated in the interior of the pressure vessel 1. In the housing 15 the pressure is the

same as in the reactor vessel 1, with the interior of which the housing communicates through the orifice 6. An orifice 16 provided in the vicinity of the upper end of the tube 4 provides an outlet for coolant introduced into the tube at the lower end into the space in the pressure vessel 1 situated above the reflector 3.

The two control elements 7 are coupled together by the cable, for example by rotation of the driving roller 12 by means of an electric motor not shown, they move simultaneously by the same distance in directions opposite to each other.

The rods 7 are shown in Fig. 1 in a position in which they occupy together the extent of the reactor core 2. They are here in a position in which the neutrons are strongly absorbed. For reducing the neutron absorption, the control elements 7 are moved away from each other by anti-clockwise rotation of the driving roller 12. They then travel simultaneously through the same distances until they reach, for example, the position 7' indicated by broken lines. The neutron absorption is of equal magnitude for the upper and lower halves of the reactor not only for full insertion of the control elements but also in intermediate positions. The heat generation in the reactor is thus distributed substantially more uniformly than when the control elements are inserted from one side only.

If the rods 7 are, as shown, inserted as far as the middle of the reactor, they together have the same effect as a single rod of double the length. For withdrawal of the rods, however, a free space of the length of a single element only is required. This needed space, however, can be reduced still further by arranging two or more relatively short control elements in the form of a chain instead of each rod 7. The deflecting roller 14 can then be arranged closer to the reactor since this chain can be passed over the deflecting roller.

Figs. 2 and 3 show a portion of such a constructional form. The control channel is here formed by a cylindrical hollow body 17. Several control elements 18, each of which consists of a metallic container 20 filled with a neutron-absorbing substance 19, such as boron, cadmium or hafnium, are arranged in the form of a chain. The chain of control elements shown in Figure 2 replaces the lower rod 7 shown in Figure 1, there being a similar chain of control elements (not shown) which replace the upper rod 7. The two chains of control elements, instead of being connected together by the cable 8, are connected together by a chain 21 made of a substance having low neutron absorption. A wall 22 separates the spaces 18*a* and 21*a* provided for the control elements 18 and for the chain 21, it being understood that the upper half of the cylindrical hollow body 17 has the space 18*a* for the upper chain on the right and the space 21*a* for the chain on the left. In other words, the space 18*a* shown in Figure 2 leads upwards into an upper space of smaller cross-section for the chain links connected to the upper one of the control elements 18, while the space 21*a* shown in Figure 2 leads upwards into an upper space of greater cross-section which receives the upper chain of control elements connected to the part of the chain 21 shown in Figure 2.

As shown in Figures 4 to 6, the control elements may be passed over a chain wheel 23 replacing the deflecting roller 14 of Figure 1. It is thus possible to bring this chain wheel close to the end of the hollow body 17 confining the control channel, and yet in case of need to withdraw the entire row of control elements 18 from the channel. The chain wheel 23 is provided with forked teeth 24, which engage between the individual control elements 18 and carry the connecting pins 25 of the elements 18 and the individual links of the chain 21. Since the links of this chain 21 in the example shown have only a third of the length of the control elements 18, the teeth 24 in the range of the chain 21 engage only one third of the connecting pins. A roller 26 serves to introduce the chain 21 into the hollow body 17 parallel to the control elements 18.

The same form of chain wheel 23 is provided at the upper end of the hollow body 17, in which case one of the chain wheels can be used for driving the regulating device.

Instead of the control elements being guided over a chain wheel, they can also be wound on a drum. In any case, however, provision should be made by some means for the two rows of control elements arranged on opposite sides of the reactor to be wound up simultaneously by the same amount.

WHAT WE CLAIM IS:—

1. A device for regulating a nuclear reactor comprising at least one pair of neutron-absorbing control elements arranged for insertion into the reactor so as to vary its reactivity, in which the elements of a pair are arranged on opposite sides of the reactor and are so coupled together that, on operation of the regulating device, they move simultaneously by substantially the same distance in opposite directions to each other.

2. A device according to claim 1, in which the control elements are connected together by a cable or chain.

3. A device according to claim 1, in which two or more control elements are arranged in the form of a chain.

4. A device according to claim 2, in which the individual elements consist of con-

tainers filled with a neutron-absorbing substance.

5. A device according to claim 3, in which a suitably formed chain wheel is arranged outside the reactor core and guides and deflects the chain formed by the individual elements.

6. A device according to claim 3 in which drums for winding up the elements arranged in a chain are mounted outside the reactor core.

7. A device for regulating a nuclear reactor substantially as described with reference to Figure 1 or Figures 2 to 6 of the accompanying drawings.

8. A nuclear reactor having a regulating device according to any preceding claim.

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3 SHEETS
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SHEET 1

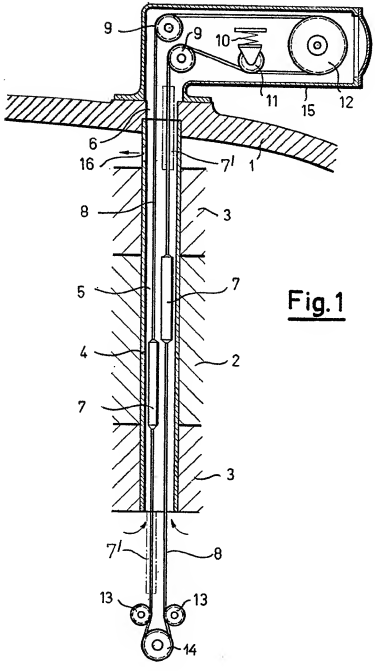

Fig. 1

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SHEETS 2 & 3

g.2

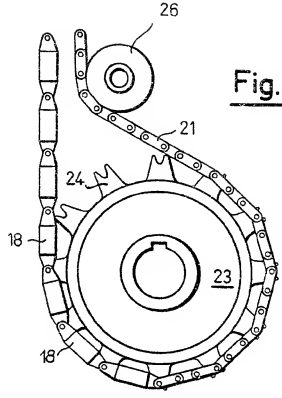
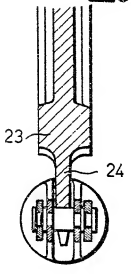


Fig. 4

Fig



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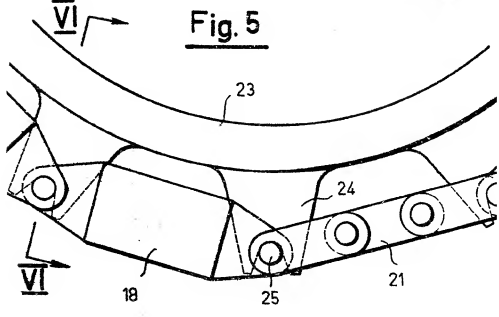

Fig. 5

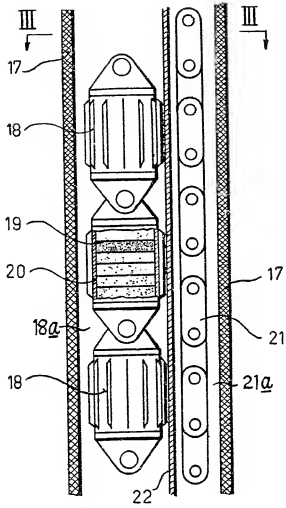
III
III
17
18
19
20
18a
18
17
21
21a
22

Fig. 2


18
18

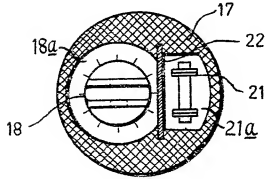
17
18a
22
21
18
21a

Fig. 3


VI
VI

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SHEETS 2 & 3

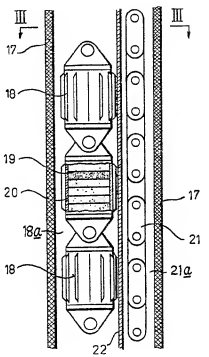

Fig. 2

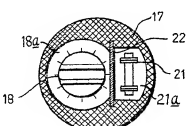

Fig. 3

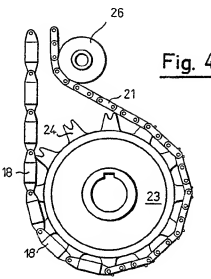

Fig. 4

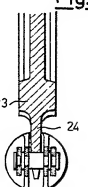

Fig. 6

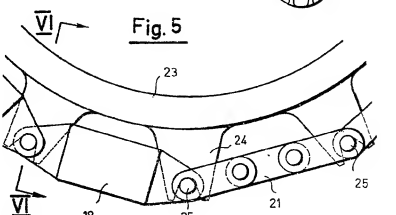

Fig. 5